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ABSTRACT

In response to criticism aimed at the quality and effectiveness of American schools, especially in the areas of mathematics and science where American students were found to take considerably fewer courses than their foreign counterparts, most states raised course work requirements for high school graduation. To examine the effects of the state policy changes and the relationship between course-taking and student characteristics, data collected on eleventh grade students by the 1983-84 National Assessment of Education Progress (NAEP) were analyzed. Results indicate that course-taking varies by racial/ethnic group and by level of parental education. White and nonlanguage minority Asian students whose parents had some postsecondary education are more likely to take college-preparatory mathematics and advanced science courses than are students of other racial/ethnic groups or students from families with less formal education. Data from the 1985-86 NAEP and from questionnaires completed by students who took the College Board Scholastic Aptitude Test show that, between 1982 and 1984, significant increases occurred in the percentage of students taking all levels of college preparatory mathematics and science courses; few changes were noted in mathematics and science course-taking, with the exception of biology, between 1984 and 1986. (30 references) (KM)

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Course-Taking Patterns in the 1980s

Margaret E. Goertz

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Margaret E. Goertz

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ABSTRACT

The decade of the 1980s has been a time of renewed debate about the quality and effectiveness of public education in the United States. A major criticism leveled against the system was a lack of rigor and declining academic standards in the nation's schools. In particular, American students were found to be taking considerably fewer mathematics and science courses than students in other countries. In response to these criticisms and to the recommendations of numerous study commissions, especially the National Commission on Excellence in Education, most states raised course work requirements for high school graduation. Little is known, however, about the impact of these and other public policy changes on student course-taking.

This study uses data collected on eleventh grade students by the 1983-84 National Assessment of Educational Progress (NAEP) to establish a baseline for examining the effects of changing state policies on student course-taking and on the relationship between course-taking and student characteristics. It looks at (1) how, and to what extent, courses taken by these students differed by selected student characteristics; (2) how, and to what extent, student demographics, parental education, availability of study aids, education aspirations and selected school characteristics affected course-taking; and (3) whether these relationships differed across racial/ethnic groups.

Analyses of the 1983-84 NAEP data show that course-taking at the eleventh grade varies by racial/ethnic group and by level of parental education. White and non-language minority Asian students whose parents had some postsecondary education are more likely to take college-preparatory mathematics courses and advanced science courses than are students of other racial/ethnic groups or students from families with less formal education. A simple model of the determinants of course-taking showed that for most racial/ethnic groups, students' educational expectations contributed significantly to differences in the number of courses taken by eleventh graders. The level of parental education and number of study aids in the home, proxy measures of student SES, also had a positive relationship with course-taking by White and, to a lesser extent, Black students. These findings are consistent with other studies of high school students.

The study also examines trends in course-taking by high school students between the years 1982 and 1987 using data from the 1985-86 NAEP, transcript studies conducted by NCES and Westat, Inc., and questionnaires completed by students who took the College Board's Scholastic Aptitude Test (SAT). There were large increases in the percentage of students taking all levels of college preparatory mathematics and science courses between 1982 and 1987 and the changes were significant across gender and racial/ethnic groups. Most of these increases occurred, however, between 1982 and 1984. The data show few changes in mathematics and science course-taking between 1984 and 1986, with the exception of biology.

These preliminary findings provide a baseline for assessing the impact of the education reform movement on student course-taking at the secondary school level and raise a number of hypotheses to be tested by further research. Information from subsequent NAEP assessments will enable researchers to examine how policies such as increased graduation requirements affected the number and type of courses that students took in the late 1980s; the relationship of course-taking to student socio-economic status, race/ethnicity and curricular track; and the number, type and variation in course work requirements and course offerings across the nation's high schools.

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* * * * * * * * * * * * *

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INTRODUCTION

The decade of the 1980s will be remembered as a time of renewed debate about the quality and effectiveness of public education in the United States. The debate was sparked by the publication in 1983 and 1984 of over a dozen reports that sounded a common theme: the American educational system is in trouble. A Nation at Risk, a report of the National Commission on Excellence in Education (NCEE), issued the strongest indictment of the system: the average graduate of the country's schools and colleges in the early 1980s was not as well-educated as "the average graduate of 25 or 30 years ago, when a much smaller proportion of our population completed high school and college" (NCEE, 1983). All of the studies concluded that students in the United States were not receiving the type of education necessary to meet the demands of a technological society or to maintain the nation's competitive economic position internationally.

One criticism leveled by study commissions was that students are exposed to a much less rigorous education program than in years past. As the student population became more diversified, and as students became more politicized in the late 1960s, education reformers called for alternative schools, electives and experience-based curricula to meet the needs and demands of all high school students. At the same time, many colleges and universities lowered entrance standards to provide greater access to higher education. High schools responded by diversifying their curriculum. The number of courses offered by American high schools doubled between 1960 and 1972. While advanced courses held their own or expanded somewhat during this period, most of the growth in curriculum was in remedial courses, courses in everyday living, and interdisciplinary programs (Powell, Farrar and Cohen, 1985).

These changes contributed to a gap in the courses taken by American and foreign students. At a time when colleges and universities in the United States were reducing the amount of mathematics and science required for admission, Japanese secondary schools were requiring college-bound students to take three natural science courses and four mathematics courses during a

three-year program. While students in the Soviet Union were taking five years of compulsory physics courses and four years of chemistry, only 21 percent of American high school students took one or more years of physics and 38 percent took one or more years of chemistry (National Task Force on Education for Economic Growth, 1982).

The National Commission on Excellence in Education argued that all students, whatever their educational or work objectives, should take a core of courses they dubbed the "New Basics." They recommended that state and local high school graduation requirements be strengthened to include a minimum of 4 years of English, 3 years of mathematics, 3 years of science, 3 years of social studies, and one-half year of computer science. Two years of a foreign language was recommended for college-bound students (NCEE, 1983). In response to these recommendations, 42 states raised course work standards for high school graduation (Goertz, 1988).

The major purpose of this study is to establish a baseline for examining the impact of changing state course work requirements on student course-taking and on the relationship between course-taking and student characteristics. It uses data from the 1983-84 administration of the National Assessment of Educational Progress (NAEP) to answer three questions about the patterns of course-taking in that year:

- How, and to what extent, did the courses taken by eleventh grade students in 1984 differ by student characteristics?
- How, and to what extent, did student demographics, parental education, availability of study aids and educational aspirations affect course-taking in 1984?
- Did these relationships differ across racial/ethnic groups?

A second purpose is to provide preliminary information on changes in course-taking during the early years of the reform. Using data from the 1983-84 and 1985-86 NAEP assessments, the High School and Beyond (HS&B) data base, the 1987 High School Transcript Study and the College Board, the paper addresses the question:

- How, and to what extent, did course-taking at the high school level change during the period 1982 to 1987?

The report is divided into five sections. The first section summarizes existing research on student course-taking. The second section describes the

study methodology and data bases and discusses the strengths and weaknesses of the NAEP data. The third section focuses on course taking patterns in the eleventh grade in 1983-84, while the fourth section examines trends in high school course taking between 1982 and 1987. The final section relates these findings to previous research and discusses the implications of these findings for studying changes in the kinds of courses students take and in the factors that affect course-taking.

RESEARCH ON STUDENT COURSE-TAKING

Recent research on student course-taking has focused on (1) course-taking opportunities; (2) course-taking patterns; and (3) relationships between course-taking and student achievement.

Course-taking Opportunities

Students usually can take only those courses that are offered by their schools. Since 1972, schools have generally expanded their course offerings. Using data from the National Center for Education Statistics (NCES) surveys of course offerings and course enrollments in 1972-73 and 1981-82, West, Diodata and Sandberg (1984) found an increase in the percentage of high schools offering lower and upper level mathematics courses, general biology, vocational education courses, and art and music. By 1982, 90 percent of all high schools offered algebra 1, geometry, general biology, chemistry and music. Eighty percent offered physics and intermediate algebra, but only 12 percent offered a course in calculus (West, Miller & Diodata, 1985). Grossman et al. (1985) examined curricular changes in California comprehensive high schools after the state mandated more extensive high school graduation requirements and the California university systems enacted stricter entrance requirements. They found large increases in the number of Advanced Placement (AP) courses and in the number of mathematics, science, computer science and foreign language sections offered, but a decrease in the number of sections in home economics, industrial arts and business education.

Do students attending different kinds of schools have equal access to a full range of courses? In 1982, students enrolled in schools with fewer than 500 students, schools in rural communities, and/or schools outside the North had less access to advanced level mathematics and science courses than other students (West, Miller & Diodata, 1985). Students who attended schools with high socio-economic status (SES) student bodies were four times as likely to have had access to AP courses as students enrolled in low SES schools. Mathematics and foreign language requirements in the college preparatory

track were also more stringent in the high SES schools (Ekstrom, Goertz & Rock, 1988).

Changes in state course work requirements should increase educational opportunities for low SES students. In California, schools with lower levels of parental education showed the largest increase in the number of academic offerings after the state imposed more stringent requirements (Grossman et al., 1985). Clune (1989) studied the school and district-level response to increased high school course work requirements in four states in the mid-1980s. On the average, schools in his sample of districts added four sections of mathematics and five sections of science, primarily at the basic, general or remedial level.

Course-taking Patterns

One may find more variation in the number and kinds of courses students actually take than in the course-taking opportunities available to them. There are few differences in those subjects frequently prescribed by the state (e.g., English and social studies). Course-taking in mathematics, science and foreign language, however, often differs by curricular track and by certain student background characteristics, such as race/ethnicity and socio-economic status.

In 1982, the average high school graduate took 2.2 years of science and 2.7 years of mathematics in a four-year program. Data collected from the High School and Beyond (HS&B) survey show that the percentage of students who took high-level courses in these fields was small: algebra 2, 31 percent; calculus, 6 percent; chemistry, 24 percent and physics, 11 percent. Students in an academic curricular track were considerably more likely to take these courses than were students in a vocational track. For example, 46 percent of academic track students took chemistry compared to 6 percent of vocational track students. Physics had curricular track differences of 21 to 4 percent; those for algebra 2 were 52 to 13 percent (NCES, 1984b).

Differences in course-taking are related only in part to curriculum track placement. For example, analyzing the same HS&B data, Ekstrom (1985) found that 60 percent of the White students in the general curriculum took algebra 1, but only 44 percent of the Black students did so. In contrast, 63 percent of the Black students in the general curriculum took general mathematics

compared with only 39 percent of the White students in this curricular track. Laing, Engen & Maxey (1987) found that among college-bound students taking the ACT, considerably more Asians took four or more years of mathematics (79 percent) and science (73 percent) than did Whites (57 percent for both subjects), Blacks (46 percent for mathematics and 50 percent for science) and Hispanics (55 percent for mathematics and 58 percent for science).

Across all curriculums, only five percent of Black and Hispanic students in the HS&B study took physics compared to 13 percent of White students and 27 percent of Asian high school students. Twenty percent of the Black, about 30 percent of the White and more than 40 percent of the Asian students took chemistry and algebra 2. High SES students were three times as likely to enroll in chemistry, five times as likely to enroll in physics and 2-1/2 times as likely to enroll in algebra 2 as were low SES students (NCES, 1984b).

Ekstrom, Goertz and Rock (1988) analyzed a more extensive set of determinants of course-taking among high school students, including SES, home support, ability, curricular track and student behaviors. Their model explained one-half to three-quarters of the variation in the number of non-remedial mathematics, science and foreign language courses taken by students in the HS&B sample. The variables that were consistently and positively related to the number of courses were (1) being in the academic curriculum, (2) tested achievement as a high school sophomore, (3) having a mother with high educational aspirations, (4) not being a disciplinary problem and, with the exception of science courses, (5) attending a Catholic school. Socio-economic status had little or no direct effect on the number of mathematics or science courses students took. SES was a major determinant of selection into the academic curriculum, however.

Relationship between Course-taking and Achievement

There appears to be consensus among researchers that quantity of schooling is positively related to academic achievement. Whether achievement is measured by ACT tests (Laing, Engen & Maxey, 1987), SAT tests (Alexander & Pallas, 1984; Sebring, 1987), or tests developed for NCES' National Longitudinal Survey (Schmidt, 1983) and HS&B studies (L. V. Jones, et al., 1986; Ekstrom, Goertz & Rock, 1988), higher test scores are associated with

spending more time in related course work. This relationship is especially strong in subject areas that are most sensitive to formal schooling, such as mathematics and science. The level of courses taken and grades in these courses also contribute to tested achievement.

In summary, research shows that increased exposure to academic curriculum has a positive effect on student achievement. In the past 15 years, school districts have expanded the range of courses available to students. Most high schools now offer basic courses in mathematics, science, art and music. The availability of advanced mathematics, science and foreign language courses, as well as Advanced Placement programs, is more limited. Students who attend high SES schools, live in urban or suburban communities, and/or attend medium or large schools have greater access to these educational opportunities. The interaction of curricular track placement and student background characteristics explain much of the variation in actual course-taking among high school students.

STUDY METHODOLOGY

This section describes the structure of the analyses, provides an overview of the data bases used in this study, and discusses the strengths and weaknesses of the NAEP data bases.

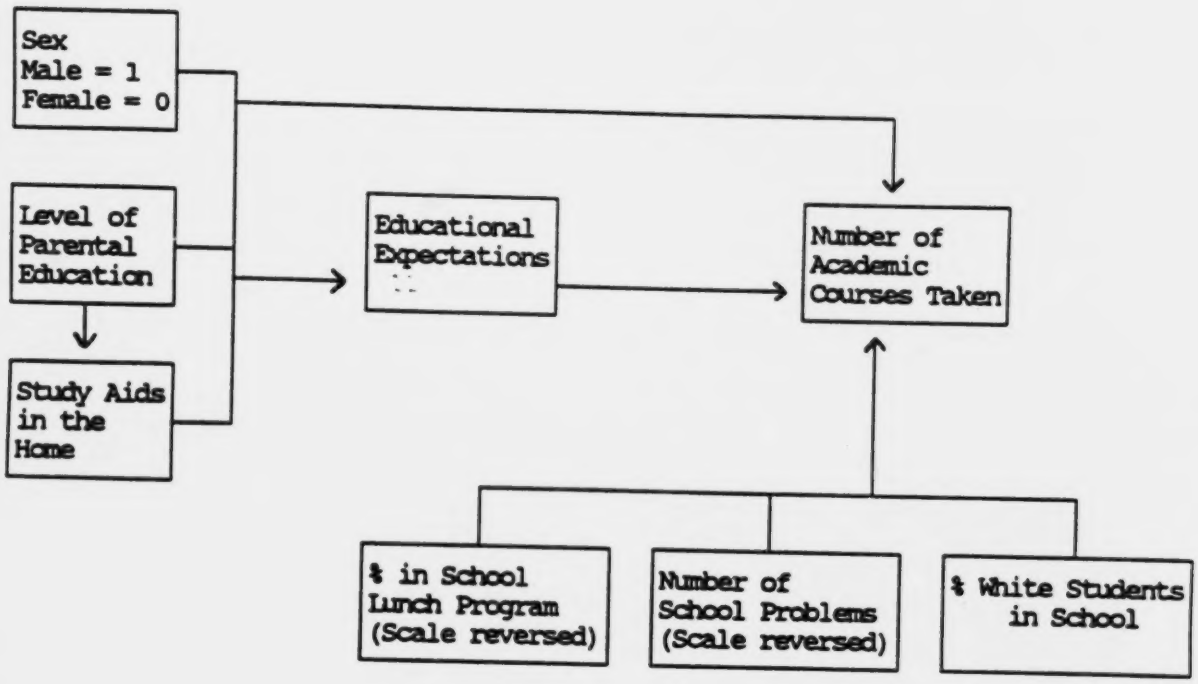
Structure of Analyses

This paper reports the findings of three sets of analyses. First, it describes the kinds of courses taken by eleventh grade students included in the 1983-84 NAEP and variations in course-taking by sex, race/ethnicity, language use and parental education. In order to describe course-taking patterns, we cross-tabulated specific courses taken by eleventh grade students with four student background characteristics: sex, level of parental education, race/ethnicity and language use. We used the six race/ethnicity/language background groups developed by Baratz-Snowden and Duran (1987): non-language minority Whites; non-language minority Blacks; non-language minority Hispanics; language minority Hispanics; non-language minority Asians; and language minority Asians. The group sample sizes varies from a low of 185 for Asian non-language minority students to more than 13,000 White students.

Second, relational analyses were conducted using these 1983-84 data to investigate the relationships among student background characteristics, school characteristics and the total number of courses taken by students in the eleventh grade. These analyses are cast in a path analytic framework which in turn leads to an orderly sequence of regressions. Since the data are cross-sectional, the ordering of the regressions necessarily follows a logical specification rather than a temporal ordering. The specific logical ordering used here is, of course, debatable, but it is not inconsistent with that found in the school achievement literature. But, because of the limitations inherent in the cross-sectional data, the present analysis can best be thought of as an exercise in explanatory modeling rather than causal modeling.

Figure 1 presents the hypothesized path model. The dependent variable is the total number of years of reported course work in English, social studies, mathematics, science and foreign language. The independent

Figure 1
Hypothesized Path Model Assumed to Underlie
Number of Academic Courses Taken


Sex
Male = 1
Female = 0
Level of Parental Education
Study Aids in the Home
Educational Expectations
Number of Academic Courses Taken
% in School Lunch Program (Scale reversed)
Number of School Problems (Scale reversed)
% White Students in School

variables are sex, level of parental education, number of study aids in the home, and educational expectations. Because research has shown that the availability of courses can be related to school characteristics, three school variables are also included in the regression analyses. They are the racial composition of the school, the poverty level and a measure of school climate. The one-way arrows indicate the hypothesized direction of the influence. In order to make contrasts among racial/ethnic groups, language and non-language minority students, and different grade levels, the path analysis/regressions were run separately by grade and by the six racial/ethnic and language background groups.

Third, two sets of comparisons are made of high school course taking. First, data from the 1987 High School Transcript Study and the transcript component of the 1982 High School and Beyond (HS&B) study and self-reports of specific mathematics and science courses taken by eleventh graders who participated in the 1983-84 and 1985-86 NAEP assessments were used to compare course-taking in mathematics and science during the period 1982 to 1987. Second, self-reported data from the Student Descriptive Questionnaire, a background questionnaire for the Scholastic Aptitude Test, provided comparisons of course-taking for college-bound seniors in 1982 and 1987.

The NAEP Data Bases

This study primarily uses student and school background data collected in the 1983-84 and 1985-86 National Assessment of Educational Progress (NAEP)[1]. NAEP is an ongoing, Congressionally-mandated project established to conduct national surveys of the educational attainment of young Americans. It is funded by the U. S. Department of Education and administered by Educational Testing Service (ETS). Since 1969, NAEP has assessed 9-year-olds, 13-year-olds and 17-year olds. The subject areas assessed have included reading, writing, mathematics, science, and social studies, as well as citizenship, literature, art, music and career development. In 1983, NAEP began sampling students by grade as well as by age. The data reported here are from students in grade 11.

---

[1] A detailed description of the NAEP methodology is contained in Beaton (1986).

The NAEP assessment employs a stratified three-stage sampling design. The first stage of sampling entails defining primary sampling units (PSUs)--typically counties, but sometimes aggregates of small counties; classifying them into strata defined by region and community type; and randomly selecting among them. For each age and grade level, the second stage entails enumerating, stratifying, and randomly selecting schools, both public and private, within each PSU selected at the first stage. The third stage involves randomly selecting students within a school for participation in NAEP.

The NAEP sample was nationally representative of school children in grades 4, 8 and 11 in 1983-84 and of students in grades 3, 7 and 11 in 1985-86. The racial/ethnic composition of the eleventh grade sample in both years was 74 percent of White students; 15 percent Black students; and 8 percent Hispanic students. Asians comprised about 2 percent of the sample.

The analyses of course-taking in the eleventh grade used student and school background variables, as well as measures of student course-taking, from the 1983-84 NAEP student and school background questionnaires and from the 1985-86 NAEP student questionnaires. The specific variables are defined below.

Racial/ethnic classifications. This report groups students into four racial/ethnic groups: Whites, Blacks, Hispanics and Asians. Students were so identified by self-report in answer to the following questions:

1. Are you:

   - o American Indian
   - o Asian or Pacific Islander
   - o Black
   - o White
   - o Other (What?)

2. Are you Hispanic?

   - o No
   - o Yes, Mexican, Mexican American, or Chicano
   - o Yes, Puerto Rican
   - o Yes, Cuban
   - o Yes, other Spanish/Hispanic (What?)

Students who identified themselves as Hispanics in question 2 were included in the Hispanic sample regardless of their response to question 1. The numbers of students who reported they were American Indian or Other

were too small to yield reliable estimates in analyses like those presented in this report.

Language minority student.[2] This variable was used in the analysis of the 1983-84 NAEP data. Students were designated language minority if they answered either "Spanish" or "Another language" to the question:

What language do most people in your home speak?

- o English
- o Spanish
- o Another language

This category includes students with diverse language skills, encompassing students who may be bilingual, those who may be monolingual English speakers, and those whose skills in English may be quite limited. Students whose knowledge of English was judged by the school to be insufficient to participate in NAEP were excluded from the test administration and thus from these analyses[3].

Parental education level. Parental education level was determined by students' responses to two separate questions about both their father's and mother's education level:

How far in school did your [mother/father] go?

- o Did not finish high school
- o Graduated from high school
- o Went to another school after graduated from high school
- o Graduated from college
- o I don't know

Students' parental education level was then determined by the highest level either parent had attained. The first four categories (excluding "I don't know") were used in the regression analyses. In the descriptive analyses, data on parental education were collapsed into three categories: not a high

---

[2] This definition was used by Baratz-Snowden and Duran (1987) in their analysis of the educational progress of language-minority students. Tables in this report which group students by language-minority status are drawn from that study.

[3] LEP excluded students represent less than two percent of the NAEP sample. They are predominantly Hispanic, with a sizeable proportion also coming from Asian language speaking backgrounds.

school graduate; high school graduate; and postsecondary experience--went to another school after high school and/or graduated from college.

Home study support items. Five items were used in the home study support scale. Students were asked to answer "Yes," "No," or "I don't know" to the following questions:

- Does your family get a newspaper regularly?
- Is there a dictionary in your home?
- Is there an encyclopedia in your home?
- Are there more than 25 books in your home?
- Does your family get any magazines regularly?

The scale, which ranges from 0-5, is the total number of "Yes" responses to these questions.

Educational expectations. Eleventh graders were asked "What will take most of your time in the year after high school: no plans, working part-time, full-time homemaker, military, working full time, apprenticeship, vocational courses, academic courses, or four-year college or university?" A four point scale was created from this question, ranging from 1 = planning to work, enter the military or become a homemaker to 4 = planning to attend a four-year college.

Course-taking. In 1983-84, all eleventh grade students were asked how many years of English, social science, mathematics, science and foreign language they had taken since the beginning of tenth grade. In addition, a sample of students was asked whether they had taken or were presently enrolled in the following science and mathematics courses: general science, biology, chemistry, computer programming, general math 1, general math 2, algebra 1, algebra 2, geometry and calculus. Data on enrollment in a wide range of vocational education courses were also collected. The text of these questions is included in Appendix A.

In the 1985-86 NAEP, all eleventh grade respondents were asked if they had taken the following science and mathematics courses: general science, biology, chemistry, physics, computer competence, computer programming, general business or consumer math, pre-algebra, first-year algebra, second year algebra, geometry, trigonometry, and pre-calculus or calculus. The text of these questions is included in Appendix B.

School variables. Three school variables were included in the regression analyses: racial composition, poverty level and school climate. The racial

composition of the school is based on principal reports of the percent of students who are White. Schools were then characterized as predominately White (80-100% White) or predominately minority (0-49% White). Poverty is defined by the percent of the student body that receives free or subsidized school lunches. The scale was reversed so that a high number means a school has little poverty.

The school climate scale was created from the principals' responses to the following questions:

> Below is a partial list of school problems. To what degree (serious, moderate, minor or not a problem) are they characteristic of your school?
>
> - Student absenteeism
> - Lack of parent interest
> - Discipline
> - Lack of teacher commitment or motivation
> - Teacher absenteeism
> - Teacher turnover
> - Low standards for students

The scale is the average score of each principal's response across the seven items, where 1 = serious and 4 = not a problem. A high score is associated with a positive school climate.

The 1987 High School Transcript Study

Two additional sources of information on course-taking at the high school level were used to show trends in student course-taking in the mid-1980s. The first of these sources was the 1987 High School Transcript Study conducted by Westat, Inc. for the National Center for Education Statistics. In this study, transcripts were collected from a nationally representative sample of high schools selected for the 1985-86 NAEP. Only those students who were in eleventh grade in 1985-86 were included but transcript data included courses taken in the twelfth grade. The data reported in this paper were drawn from tabulations prepared by Westat, Inc. for the U.S. Department of Education's Nation at Risk Update Study (NARUS). Their analyses were based on approximately 15,000 transcripts of 1987 high school graduates drawn from the 1987 High School Transcript Study and 12,000 transcripts of 1982 high

school graduates who participated in the High School and Beyond study[4] (Westat, 1988).

The NARUS analyses show the percent of 1982 and 1987 high school graduates who took selected courses and present the statistical significance of the change in course-taking between these two years. Students were grouped by a number of background characteristics as well. We focused on course-taking in five mathematics subjects--algebra 1, algebra 2, geometry, pre-calculus and calculus--and three science subjects--biology, chemistry and physics. In this paper, students are classified by three of Westat's descriptors: sex, race/ethnicity and curricular track.[5]

The Scholastic Aptitude Test (SAT)
Student Descriptive Questionnaire

Another source of information on course-taking trends is the Student Descriptive Questionnaire (SDQ) of the SAT. Each year, SAT-takers are asked to answer a set of questions about their background, academic record, extracurricular activities and plans for college study. Approximately 95 percent of the test-takers complete the SDQ. Information from this data base is reported annually by the College Board in its profile of college-bound seniors. While the respondents do not represent all high school seniors or all students who enroll in colleges and universities, they include nearly 1.2 million college-bound high school seniors.

In 1982, students were asked to report how many years of study they expected to complete in six areas--English, mathematics, foreign languages, biological sciences, physical sciences and social studies. In 1987, they were asked to indicate the total number of years of high school courses they had

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[4] This sample is limited to high school graduates and to those students who did not participate in a special education program.

[5] For the purposes of the NARUS analyses, Westat placed students in the "academic track" if they earned at least 12 credits in the core areas of English, history and social studies, mathematics and/or science and did not meet the requirements for the vocational track. If students earned at least 3 credits in a single occupationally specific vocational education area and had not met the requirements for the academic track, they were classified in the "vocational track." If they had not met the requirements for either the academic or vocational track, they were classified as "neither track." We retitled this last classification "other."

taken or planned to take in six areas--English, mathematics, foreign and classical languages, natural sciences, social sciences and history and art and music. (The text of these questions is included in Appendix C.) Test-takers were also asked about participation in specific courses in foreign and classical languages, mathematics, natural sciences and social sciences and history. These data were not available prior to 1987, however.

Limitations of the NAEP Data Base

There are three limitations to the NAEP data bases that can affect the analyses presented in this report: (1) an inadequate measure of student socio-economic status; (2) reliance on student self-reports of background information and of courses taken; and (3) limited information on curriculum offerings in the schools.

First, NAEP asks only two questions that can be used to measure the socio-economic status of the individual student--the number of study items in the home and level of parental education. The NCES surveys, on the other hand, collect information on parental occupation and income as well. NCES then combines data on parental occupation, education and income with the number of items in the home to create a composite measure of SES.[6]

Second, student data are self-reported and are not cross-checked with other sources, such as school records or parent surveys. An examination of parent and student responses in the High School and Beyond data set revealed 90 percent agreement between parents and 12th grade students on father's educational attainment (NCES, 1984a). In a recent survey of parents of language minority students, Baratz-Snowden (1988) found a 63 percent agreement between parent and eleventh grade student reporting of father's education.

The validity of student self-reports of course-taking has also been questioned. NCES (1984a) investigated this issue with the HS&B survey of 1982 seniors using student transcripts. They found that the quality of student reports on amount of course work (e.g., the number of years the

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[6] Each of the five components is standardized separately and the components are then averaged to form the raw SES score. This is then divided into quartiles. (See C. Jones, et al., 1983, for a description of this procedure.)

student took of a particular subject) differed by subject area. Correlation coefficients ranged from about 0.87 for foreign languages to about 0.70 for science and mathematics to less than 0.40 for English or social studies, areas where there is relatively little variation in the amount of course work that students take. The quality of student reports of specific courses taken was similar: coefficients were in the 0.80s for chemistry, physics and geometry and in the 0.60s for advanced mathematics courses. Data quality was slightly higher for females than for males, and considerably higher for White students, high-achieving students and students from high SES backgrounds than for Hispanics or Blacks, low-achieving students and students from low SES backgrounds.[7]

Third, the 1983-84 NAEP did not ask principals about course offerings or course work requirements in their schools. Nor did it ask schools or students what curricular tracks (e.g., academic, general education, vocational) they were enrolled in. Therefore, we do not have any information on student access to curriculum. Nor can we construct a "typical" core curriculum for students in different high school programs.

Advantages of the NAEP Data Base

Despite these limitations, NAEP is the best source of information for examining trends in course-taking in the 1980s, a decade of educational change. NAEP has two major advantages over other data bases. First, NAEP is timely. As it assesses students and collects background information every two years, it is the only nationally representative survey of students that can be used to examine the immediate impact of state course work reforms. NCES' longitudinal surveys are conducted on a eight to ten year cycle. Thus, NCES will not have new information on course-taking patterns of high school seniors until 1992.

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[7] L. V. Jones et al., (1986) found that the use of student self-reports in the HS&B survey had little effect on the observed relationship between course-taking and mathematics and science achievement. In fact, the relationship in mathematics was slightly stronger for courses students reported taking than for courses as recorded on the student's high school transcript. The use of the two different data sources did not affect the relationship in science.

Second, NAEP is a nationally representative sample of students. Other surveys of high school course-taking, such as the Student Descriptive Questionnaire and the ACT Student Profile Section, collect information on an annual basis. However, their data are limited to college-bound high school students, a group that takes a different mix of courses than their non-college bound classmates (c.f., Sebring, 1987).

In addition, some of the data problems discussed in the preceding section are being addressed by NAEP or by the federal government. For example, starting with the 1985-86 assessment, NAEP collected more information on the academic background of high school students. Students are now asked to report their curricular track. Principals are asked a number of questions about the academic setting of their schools, such as the percentage of students in the academic, general and vocational programs; the percentage of students who are college-bound; school district course work requirements for a high school diploma; and the availability of selected advanced academic courses. The federal government funded the collection of transcripts from high school students attending schools sampled in the 1985-86 NAEP (see Westat, 1988). Funds were not provided, however, to assess the reliability of student self-reports of courses taken and curriculum membership using these transcript data. A preliminary comparison of the percent of students taking selected courses using the self-report and transcript data shows a high degree of correspondence (with the exception of algebra 1), however.

COURSE-TAKING PATTERNS IN THE ELEVENTH GRADE, 1983-84

The NAEP data show few, if any, differences in the kinds of mathematics and science courses taken by eleventh grade men and women (Table 1). Female students were just as likely to have taken algebra 1 and algebra 2, geometry and calculus, as well as biology, chemistry and computer programming as male students. Table 2 shows, however, that differences in course-taking occur across racial/ethnic groups. For example, a larger percent of White and Asian students report having taken college preparatory mathematics and chemistry courses than did Black and Hispanic students. About two-thirds of the White and non-language minority Asian eleventh graders, but only half of the Black and non-language minority Hispanic students and one-third of the language minority Hispanics, had taken geometry by the eleventh grade. Similarly, White and Asian students were considerably more likely to have taken algebra 2 than their Black or Hispanic peers. More than 10 percent of the Asian non-language minority eleventh grade students reported taking calculus, a rate that was four to five times greater than their classmates.[8]

In the field of science, about 80 percent of the students reported taking biology, regardless of race/ethnicity. Considerable differences appear in chemistry, however. Over 60 percent of the Asian students reported taking this course, compared to 42 percent of the White and fewer than 30 percent of the Black and Hispanic eleventh graders. Blacks and Hispanics were the groups least likely to have enrolled in computer programming as well.

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[8] The percentage of Hispanic students who reported having taken calculus appears to be an anomaly. An analysis of transcript data in 1987 shows percentages for both Hispanics and Blacks that are below those of Whites. (See Table 10, p. 38, of this report.)

Table 1

Percent* of Eleventh Graders Who Have Taken
Selected Mathematics and Science Courses, by Sex
1983-1984

Courses	Male	Female
Mathematics		
Algebra 1	82.5 (1.3)**	83.6 (1.5)
Geometry	62.4 (1.6)	59.1 (2.2)
Algebra 2	53.3 (2.1)	52.1 (2.0)
Calculus	2.7 (0.5)	2.5 (0.5)
Science		
Biology	81.3 (2.0)	83.1 (1.4)
Chemistry	41.0 (2.2)	37.5 (2.4)
Computer Programming	31.6 (2.6)	26.5 (2.2)

* Percentages are weighted to yield population estimates.

** Standard errors are in parentheses.

Table 2

Percent* of Eleventh Graders Who Have Taken
Selected Mathematics and Science Courses, by Race/Ethnicity
1983-1984

	White**	Black**	Hispanic Non-LM	Hispanic Lang-Min	Asian Non-LM	Asian Lang Min
Mathematics						
Algebra 1	86.8(1.0)***	70.8(3.2)	79.0(3.7)	69.3(8.0)	97.2(2.7)	70.3(11.1)
Geometry	65.9(1.7)	46.0(4.0)	51.5(5.7)	34.8(6.7)	72.4(7.0)	55.3(14.7)
Algebra 2	56.2(2.0)	40.3(4.1)	45.9(6.2)	40.6(5.4)	71.9(14.6)	65.1(16.2)
Calculus	2.3(0.4)	1.4(0.7)	5.8(2.5)	5.9(2.7)	11.1(11.2)	2.9(2.9)
Science						
Biology	82.0(1.4)	81.7(3.5)	82.3(5.3)	86.1(6.6)	71.2(9.8)	82.5(6.3)
Chemistry	42.2(2.0)	28.6(3.8)	29.6(4.2)	22.1(4.9)	61.6(12.5)	64.9(11.4)
Computer Programming	30.6(2.5)	22.1(2.9)	21.8(6.2)	19.5(6.8)	43.8(12.5)	51.5(10.8)

* Percentages are weighted to yield population estimates.

** Figures are for non-language minority students only.

*** Standard error in parentheses.

Source: Baratz-Snowden and Duran (1987).

We find similar patterns when students are grouped by level of parental education (see Table 3.) More than 90 percent of the students whose parents had some postsecondary education reported taking algebra 1, compared to 60 percent of students whose parents had not completed high school and 78 percent of those whose parents were high school graduates. Two-thirds to three-quarters of students with college-educated parents took algebra 2 and geometry, but only 30 percent of students whose parents had not completed high school reported doing so.

Students with college-educated parents were only slightly more likely to have taken biology or computer programming than students whose parents did not have high school degrees--87 percent compared to 74 percent for biology and 33 percent versus 20 percent for computer programming. There are considerable differences in the percentage of students who took the more advanced science course of chemistry, however: 53 percent versus 21 percent.

Students also reported how many years of a foreign language they had completed. (See Table 4.) White and Hispanic students were somewhat more likely to report taking two or more years of a foreign language than were Black students. Much larger variations appear when students are grouped by level of parental education. Nearly two-thirds of those students whose parents had not completed high school reported little or no exposure to a foreign language, compared to one-third of those students whose parents had some postsecondary education. Only 15 percent of this former group had taken two or more years of a foreign language by the time they were in eleventh grade compared to nearly 40 percent of the latter group of students.

NAEP also asked eleventh grade students about their enrollment in vocational education courses. Table 5 shows the years of business and vocational education course work reported by these students. Nearly one-half of the students reported taking less than one year of course work. Another

27 percent reported taking one to 1-1/2 years and 24 percent reported taking two or more years of business or vocational courses. The years of course work reported varied considerably by sex and by level of parental education, but little by race/ethnicity. Women were more likely than men to have taken one or more years of business or vocational education courses: 57 percent versus 43 percent. About 60 percent of the students whose parents had not gone beyond high school reported taking one or more years of these courses, compared to 43 percent of the students whose parents had a post high school education.

One also finds major gender differences in the type of vocational education courses that eleventh graders reported taking. A considerably larger percentage of men than women took courses in agriculture, auto mechanics, the construction trades, drafting, electronics, machine shop and welding, while females were much more likely than males to enroll in cosmetology, home economics, food service occupations and secretarial/ office work courses. Course-taking behavior was more "gender neutral" in commercial arts, computer programming, the health fields and sales and merchandising. With the exception of computer programming, vocational course-taking behavior generally did not differ by racial/ethnic group (Goertz, 1987).

Table 3

Percent* of Eleventh Graders Who Have Taken
Selected Mathematics and Science Courses, by Level of Parental Education
1983-1984

Courses	Level of Parental Education: Not High School Graduate	High School Graduate	Postsecondary Education
Mathematics			
Algebra	60.2 (3.9)**	77.6 (1.7)	92.4 (1.1)
Geometry	31.4 (3.4)	49.0 (2.0)	75.8 (2.3)
Algebra 2	27.3 (3.2)	41.7 (1.9)	65.7 (2.6)
Calculus	2.5 (1.1)	2.1 (0.6)	3.0 (0.5)
Science			
Biology	73.8 (4.1)	78.0 (2.0)	87.2 (1.4)
Chemistry	21.1 (2.8)	25.8 (2.0)	52.6 (2.1)
Computer Program	19.8 (3.7)	24.8 (2.4)	33.3 (3.0)

* Percentages are weighted to yield population estimates.

** Standard errors are in parentheses.

Table 4

Percent* of Eleventh Graders Who Have Taken Foreign Language Courses, by Race/ethnicity and Level of Parental Education

	Years of Reported Foreign Language Course-taking		
	0-0.5 Yr.	1.0-1.5 Yrs	2.0 or more
Race/ethnicity			
White	45.0	25.4	29.8
Black	55.2	22.2	22.6
Hispanic	40.1	27.3	32.6
Parental Education			
Not Graduated High School	65.6	19.7	14.6
High School Graduate	58.1	22.8	19.2
Postsecondary Education	33.1	28.2	38.8

*Percentages are weighted to yield population estimates.

Table 5

Number of Years of Business or Vocational Course Work Completed by 11th Grade Students, by Gender, Race/Ethnicity, Level of Parental Education and Age, 1983-84

	Years of Course Work Completed (Percent* of Students)							
	None	0.5	One	1.5	Two	2.5	Three	3.5 or more
All Students	42.3(1.1)**	7.4(0.6)	24.2(0.6)	2.6(0.2)	15.9(0.6)	1.1(0.1)	3.8(0.2)	2.7(0.2)
Student Characteristics								
Gender								
Male	48.7(0.9)	7.8(0.6)	21.7(0.6)	2.2(0.2)	12.7(0.5)	0.9(0.1)	3.4(0.3)	2.5(0.3)
Female	36.1(1.5)	7.0(0.7)	26.6(0.7)	2.9(0.3)	19.0(0.8)	1.3(0.1)	4.3(0.3)	2.8(0.3)
Race/Ethnicity								
White, non-Hispanic	41.8(1.2)	7.4(0.6)	24.3(0.7)	2.5(0.2)	16.4(0.7)	1.0(0.1)	3.9(0.2)	2.8(0.3)
Black, non-Hispanic	41.4(2.3)	7.4(1.4)	24.1(1.3)	3.1(0.7)	15.8(1.5)	1.7(0.3)	4.2(0.7)	2.2(0.4)
Hispanic	46.3(2.1)	7.5(1.2)	24.5(1.1)	2.7(0.4)	12.9(1.8)	0.9(0.4)	3.1(0.7)	2.2(0.5)
Other	53.0(2.0)	7.7(1.5)	21.0(1.4)	2.6(0.6)	10.2(1.1)	0.3(0.2)	3.0(0.7)	2.2(0.7)
Parental Education								
Not High School Graduate	34.4(1.5)	5.9(0.9)	25.6(1.3)	2.7(0.4)	20.2(1.2)	1.2(0.2)	5.9(0.7)	4.0(0.5)
High School Graduate	34.9(0.9)	6.4(0.6)	26.2(0.7)	2.8(0.3)	19.7(0.6)	1.3(0.2)	5.4(0.3)	3.3(0.4)
Post High School Educ.	48.2(1.6)	8.3(0.8)	22.7(0.8)	2.4(0.2)	12.9(0.7)	0.9(0.1)	2.5(0.2)	2.0(0.2)
Unknown	45.4(2.5)	8.4(1.6)	24.0(1.9)	3.5(1.1)	12.5(1.7)	1.5(0.6)	2.6(0.7)	2.1(0.7)
Age								
16 or Younger	47.0(2.1)	6.4(0.7)	22.7(1.0)	2.1(0.5)	15.6(1.3)	0.9(0.2)	2.8(0.4)	2.5(0.5)
17 Years Old	42.0(1.2)	7.4(0.6)	24.6(0.7)	2.8(0.2)	15.5(0.6)	1.0(0.1)	4.0(0.2)	2.6(0.2)
18 or Older	39.8(1.3)	7.9(0.9)	23.6(1.0)	2.3(0.3)	17.6(1.1)	1.7(0.3)	4.1(0.5)	3.0(0.4)

Source: 1983-84 National Assessment of Educational Progress

* Percentages are weighted to yield population estimates.
** Standard errors are in parentheses.

We used path analyses to examine further the relationships among selected student background characteristics, school characteristics and the number of courses taken. These relationships were investigated via the estimation of the direct effects shown in the hypothesized path model in Figure 1.[9]

The outcome variable is the total number of years of reported course work in English, social studies, mathematics, science and foreign language. Taken together, sex, level of parental education, study aids in the home and educational expectations accounted for 25 percent to 37 percent of the variation in course-taking for all groups except language minority Hispanic students (Table 6). Parental education is positively related to the number of courses taken by White, Black and Asian language-minority students. When parental education is held constant, the number of study aids in the home also contributes positively to the course-taking behavior of White eleventh graders. Higher educational expectations were statistically related to more course-taking by White, Black, Hispanic non-language minority and Asian language minority students, but to fewer courses taken by Asian non-language minority eleventh graders.

The interaction of school and student characteristics is shown in Table 7. The addition of the three school variables does not increase the multiple R perceptibly for any of the groups, with the possible exception of language minority Hispanic and non-language minority Asian students. No one school variable is statistically significant for all groups. School SES has a minimal impact on course-taking behavior; it is a significant variable only for White students. The percentage of Whites in a school is negatively related to reported course-taking for White and Black students. School climate is not significantly related to course-taking for any of the racial/ethnic groups.

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[9] In general, a variable is considered significant if the "t" statistic of its associated partial regression weight is equal to or greater than 2.0 ("p" equal to or less than 0.05). The "t" statistics take into consideration an average sample design effect of about 2.0. The design effect modification to the statistical tests takes into consideration the fact that the sampling procedure oversampled certain strata within the target population. A design effect of 2 indicates that the variance of the statistic of interest with the present sample design is twice that for a simple random sample with the same number of observations.

Table 6

Grade 11

Direct Effects of Student Background Variables on
Number of Courses Taken,
by Racial/Ethnic and Language Subgroups

Raw Regression Weight

	White	Black	Hisp. NonLM	Hisp. LM	Asian NonLM	Asian LM
Sex-Male	0.3111*	-0.1341	0.0393	0.1925	0.0145	0.1818
Parent Educ.	0.4832*	0.2317*	0.1439	0.1916	0.3303	0.6955*
Study Aids	0.2668*	0.0541	0.1128	0.2526	0.2599	-0.2382
Educ. Expect.	0.2034*	0.4860*	0.4130*	-0.0978	-0.5099*	0.8983*

Standardized Regression Weight

	White	Black	Hisp. NonLM	Hisp. LM	Asian NonLM	Asian LM
Sex-Male	0.0586*	-0.0227	0.0070	0.0330	0.0028	0.0306
Parent Educ.	0.1876*	0.0842*	0.0580	0.0756	0.1306	0.2841*
Study Aids	0.0704*	0.0174	0.0418	0.1051	0.0834	-0.0894
Educ. Expect.	0.1031*	0.2120*	0.1996*	-0.0436	-0.2874*	0.3434*
Multiple R	0.2699	0.2469	0.2401	0.1464	0.3076	0.3745

*Statistically significant

Table 7

Grade 11

Direct Effects of Student and School Variables on
Number of Courses Taken,
by Racial/Ethnic and Language Subgroups

Raw Regression Weight

	White	Black	Hisp. NonLM	Hisp. LM	Asian NonLM	Asian LM
Sex-Male	0.3035*	-0.1182	0.0547	0.2064	-0.0154	0.1748
Parent Educ.	0.4455*	0.2145*	0.1652	0.0499	0.3683	0.7066
Study Aids	0.2566*	0.0387	0.1299	0.2246	0.1200	-0.2500
Educ. Expect.	0.1929*	0.4810*	0.4253*	-0.0944	-0.6010*	0.8736
School SES	0.0095*	0.0059	-0.0013	-0.0008	-0.0033	-0.0029
% White	-0.3044*	-0.4343*	-0.5930	0.9310	-0.8330	0.5438
School Climate	0.0241	-0.0192	0.1124	0.6912	0.9032	0.0310

Standardized Regression Weight

	White	Black	Hisp. NonLM	Hisp. LM	Asian NonLM	Asian LM
Sex-Male	0.0571*	-0.0200	0.0097	0.0354	-0.0030	0.0294
Parent Educ.	0.1729*	0.0780*	0.0666	0.0197	0.1456	0.2886*
Study Aids	0.0677*	0.0124	0.0481	0.0935	0.0385	-0.0939
Educ. Expect.	0.0978*	0.2098*	0.2055*	-0.0421	-0.3387*	0.3340*
School SES	0.0739*	0.0575	-0.0125	-0.0082	-0.0212	-0.0220
% White	-0.0516*	-0.0667*	-0.0958	0.1041	-0.1615	0.0896
School Climate	0.0041	-0.0032	0.0182	0.1174	0.1493	0.0050
Multiple R	0.2810	0.2547	0.2585	0.2170	0.3543	0.3834

*Statistically significant

TRENDS IN HIGH SCHOOL COURSE-TAKING

1982 TO 1987

In the mid-1980s, 42 states increased their course work requirements for high school graduation. Nine states initiated, reimposed or substantially expanded statewide high school course requirements. The majority of states, however, increased the total number of courses required for graduation by one or two units, and specified that students take an additional year each of mathematics, science, English and social studies (Goertz, 1986). The changes generally became effective with the graduating classes of 1987 (11 states), 1988 (10 states) or 1989 (15 states). The academic preparation of high school students was also of concern to institutions of higher education. Between 1982 and 1985, sixteen states enacted or proposed more stringent statewide admissions policies for students entering their public colleges and universities. The new high school course work requirements exceeded those required for high school graduation. College freshmen were generally expected to take an additional year of mathematics and science, one to two years of a foreign language, and electives drawn from a college preparatory curriculum (Goertz & Johnson, 1985).

What impact have these changes had on high school student course-taking? This section of the report looks at trends in course-taking during the period 1982 to 1987 using three sources of data: (1) the percent of high school graduates in the classes of 1982 and 1987 whose transcripts showed they had taken selected academic courses; (2) the percent of eleventh grade students in 1983-84 and 1985-86 who reported they had taken, or were currently enrolled in, selected mathematics and science courses; and (3) the number of years of selected academic subjects that college bound seniors in 1982 and 1987 reported they had taken.

Table 8 compares the average number of credits earned by high school graduates in different academic fields in 1982 and 1987 as reported on their school transcripts. High school graduates completed significantly more credits in English, history, mathematics, science, computer science and foreign language and fewer credits in non-occupationally specific vocational education

in 1987 than five years earlier. Enrollments in occupationally specific vocational education courses did not show a significant change.

What kinds of additional courses were students taking? What type of students chose to take more mathematics and science? When in this period of time did the increase in academic course taking occur? Tables 9 and 10 compare the percent of high school students who took selected mathematics courses at four points in time: 1982, 1984, 1986 and 1987. There were large and statistically significant increases in the percentage of students taking all college preparatory mathematics courses--algebra 1 and 2, geometry, trigonometry, pre-calculus and calculus between 1982 and 1987. With a few exceptions (calculus for women and White and Black students), the changes were significant across gender and racial/ethnic group.

We expected that most of the change in course-taking would have occurred between 1984 and 1986. In most states, reform legislation was enacted in 1983 and 1984. Provisions for increased high school course work were to become effective in more than half of the reform states with the graduating classes of 1987 or 1988. Thus, the initial impact of these changes on high school course-taking should have occurred in 1985-86, a year when many of the students subject to the new requirements were sophomores (Class of 1988) or juniors (Class of 1987).

As shown in Tables 9 and 10, however, there was little measurable change in the percent of eleventh-grade students taking college-level mathematics courses between 1984 and 1986. There was a slight increase in the percent of women who reported taking geometry and a slight decrease in

Table 8

Average Number of Credits Earned by
High School Graduates in Various Subjects Fields,
1982 and 1987*

Subject Field	1982 Graduates	1987 Graduates	Change 1982-1987
English	3.80	4.05	0.25**
History	1.68	1.91	0.23**
Social Studies	1.42	1.44	0.02
Mathematics	2.54	2.98	0.45**
Computer Science	0.11	0.42	0.31**
Science	2.19	2.63	0.44**
Foreign Language	1.05	1.47	0.44**
Non-Occup. Vocational Ed.	1.84	1.66	-0.19**
Occup. Vocational Ed.	2.14	2.09	-0.05
Arts	1.39	1.41	0.02
Physical Education	1.93	2.00	0.07

*As recorded on students' transcripts.
**Differences between 1982 and 1987 graduates are significant at 0.05 level.

Source: Westat (1988), Table 8.

Table 9

Percent* of High School Students Who Took Selected Mathematics Courses, by Sex, 1982, 1984, 1986 and 1987

Mathematics Courses	1982[1]		1984[2]		1986[3]		1987[4]	
	Male	Female	Male	Female	Male	Female	Male	Female
Algebra 1	66.3	66.8	82.5	83.6	81.0	82.3	75.8**	78.5**
Geometry	45.0	46.4	62.4	59.1	62.3	62.8	61.1**	60.8**
Algebra 2	35.3	34.9	53.3	52.1	50.4	48.6	44.1**	47.9**
Trigonometry	12.9	11.3	n.a.	n.a.	n.a.	n.a.	21.9**	19.0**
Pre-calculus	6.0	5.5	n.a.	n.a.	n.a.	n.a.	13.5**	11.3**
Calculus	5.3	4.2	n.a.	n.a.	n.a.	n.a.	7.6**	4.7

[1]Courses taken by 1982 high school graduates as recorded on student transcripts.

[2]Courses taken by eleventh grade students in 1984 as self-reported on NAEP student background questionnaire.

[3]Courses taken by eleventh grade students in 1986 as self-reported on NAEP student background questionnaire.

[4]Courses taken by 1987 high school graduates as recorded on student transcripts.

*Percentages are weighted to yield population estimates.
**Differences between 1982 and 1987 graduates are significant at 0.05 level.

Sources: 1982 and 1987: Westat (1988), Table 33. 1984 and 1986: Unpublished NAEP tabulations.

Table 10

Percent* of High School Students Who Took Selected Mathematics Courses, by Race/Ethnicity, 1982, 1984, 1986 and 1987

Mathematics Courses	1982[1]			1984[2]			1986[3]			1987[4]		
	White	Black	Hisp.	White	Black	Hisp.	White	Black	Hisp.	White	Black	Hisp.
Algebra 1	68.1	57.5	55.1	86.6	71.3	73.9	84.0	71.2	72.4	78.2**	70.7**	76.6*
Geometry	51.2	28.5	25.8	65.4	46.1	43.9	66.4	46.1	45.6	64.2**	43.6**	44.3*
Algebra 2	38.7	24.2	20.8	56.1	40.1	43.7	52.5	35.5	34.6	51.4**	32.3**	33.2*
Trigonometry	13.6	6.0	6.4	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	21.7**	12.3**	11.5*
Pre-calculus	6.7	2.2	3.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a	13.0**	5.0**	8.0*
Calculus	5.5	1.4	1.8	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	5.9	2.4	4.1*

[1]Courses taken by 1982 high school graduates as recorded on student transcripts.

[2]Courses taken by eleventh grade students in 1984 as self-reported on NAEP student background questionnaire.

3Courses taken by eleventh grade students in 1986 as self-reported on NAEP student background questionnaire.

4Courses taken by 1987 high school graduates as recorded on student transcripts.

*Percentages are weighted to yield population estimates.
**Differences between 1982 and 1987 graduates are significant at 0.05 level.

Sources: 1982 and 1987: Westat (1988), Table 34. 1984 and 1986: Unpublished NAEP tabulations.

the percent of men and women who reported taking algebra 2. The decline in the percent of students taking algebra 2 cuts across all three racial/ethnic groups as well. (Comparisons are not shown for trigonometry, pre-calculus and calculus as these courses are normally taken in the last year of high school, not by high school juniors.)

Instead we find large increases in the percentage of students taking algebra 1, geometry and algebra 2 occurring between 1982 and 1984, increases that are considerably larger than those found between 1984 and 1986. For example, the percent of men and women who took algebra 1 increased by 16 to 17 percentage points between 1982 and 1984. The increases for geometry were approximately 17 percentage points for men and 13 percentage points for women. For algebra 2, the increases were 18 and 17 percentage points respectively. White and Hispanic students were somewhat more likely to increase course-taking in algebra 1 than Black students; Black and Hispanic students showed larger percentage increases in geometry than Whites. Hispanic students showed the largest increase in course-taking in algebra 2.

These figures should be interpreted cautiously, however. The data for 1984 and 1986 are based on student self-reports of course-taking, while those for 1982 and 1987 are based on student transcripts. In addition, the 1984 eleventh graders were asked if they had taken pre-algebra or algebra 1; the 1982 transcript data are limited to algebra 1. Therefore, the student reports in 1984 may be overstating the number and type of courses taken, making the increase in course-taking larger than is actually the case. We have no way of determining the reliability of the 1984 self-reports, but the 1986 self-reports can be compared on a very gross basis with the 1987 transcript data using these tables.[10] With the exception of algebra 1 (particularly for White students), the percentages are quite close, lending face validity to the student self-reports.

Tables 11 and 12 present data on science course-taking during 1982, 1984, 1986 and 1987. There were significant changes in the percent of students taking biology, chemistry and physics overall, and across all gender and racial/ethnic groups, between 1982 and 1987. Unlike mathematics,

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[10] These are not necessarily the same students, however. Westat, Inc. collected transcripts from graduates of a nationally representative sample of high schools selected for the 1985-85 NAEP.

however, the growth in the percentage of students taking biology and chemistry was steady over the five year period. For example, the percentage of males taking biology increased by approximately 8 percentage points between 1982 and 1984 and by another 7 percentage points between 1984 and 1987. The change for women was approximately 6 to 7 percentage points in both time spans. The growth in course-taking in chemistry is concentrated more in the period 1982 to 1984 for men, but is spread out for women. A somewhat different pattern emerges when students are grouped by race/ethnicity, however. Growth in science course-taking by minority students is concentrated in the early years of the period 1982 to 1987, while changes in course-taking for White students is more evenly spread throughout the period.

Table 11

Percent* of High School Students Who Took Selected Science Courses, by Sex, 1982, 1984, 1986 and 1987

Science Courses	1982[1]		1984[2]		1986[3]		1987[4]	
	Male	Female	Male	Female	Male	Female	Male	Female
Biology	73.7	77.1	81.3	83.1	87.4	89.8	88.5**	90.8**
Chemistry	31.7	30.0	41.0	37.5	44.2	40.6	46.3**	44.5**
Physics	18.2	10.0	n.a.	n.a.	n.a.	n.a.	25.3**	15.0**

[1]Courses taken by 1982 high school graduates as recorded on student transcripts.

[2]Courses taken by eleventh grade students in 1984 as self-reported on NAEP student background questionnaire.

[3]Courses taken by eleventh grade students in 1986 as self-reported on NAEP student background questionnaire.

[4]Courses taken by 1987 high school graduates as recorded on student transcripts.

*Percentages are weighted to yield population estimates.
**Differences between 1982 and 1987 graduates are significant at 0.05 level.

Sources: 1982 and 1987: Westat (1988), Table 42. 1984 and 1986: Unpublished NAEP tabulations.

Table 12

Percent* of High School Students Who Took Selected Science Courses, by Race/Ethnicity, 1982, 1984, 1986 and 1987

Science Courses	1982[1]			1984[2]			1986[3]			1987[4]		
	White	Black	Hisp.	White	Black	Hisp.	White	Black	Hisp.	White	Black	Hisp.
Biology	77.3	70.9	67.2	82.3	81.3	84.6	89.0	88.8	82.3	91.0**	84.7**	85.9**
Chemistry	34.2	20.5	15.4	42.2	28.9	25.7	44.1	32.7	30.4	48.0**	30.3**	31.8**
Physics	16.0	6.9	5.6	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	21.1**	10.6**	11.2**

[1]Courses taken by 1982 high school graduates as recorded on student transcripts.

[2]Courses taken by eleventh grade students in 1984 as self-reported on NAEP student background questionnaire.

[3]Courses taken by eleventh grade students in 1986 as self-reported on NAEP student background questionnaire.

[4]Courses taken by 1987 high school graduates as recorded on student transcripts.

*Percentages are weighted to yield population estimates.
**Differences between 1982 and 1987 graduates are significant at 0.05 level.

Sources: 1982 and 1987: Westat (1988), Table 41. 1984 and 1986: Unpublished NAEP tabulations.

Table 13

Percent* of High School Graduates Who Took Selected Mathematics Courses, by Academic Track 1982 and 1987

Mathematics Courses	Curricular Track		
	Academic	Vocational	Other
1982 Graduates			
Algebra 1	76.7**	55.4	55.2
Geometry	73.6	17.1	26.3
Algebra 2	58.3	11.5	18.9
Trigonometry	24.5	1.1	3.4
Pre-calculus	11.8	0.5	1.5
Calculus	10.6	0.2	0.5
1987 Graduates			
Algebra 1	81.3***	67.6***	68.7***
Geometry	80.2***	20.4	29.7
Algebra 2	63.6***	11.9	16.0
Trigonometry	31.5***	1.8	3.2
Pre-calculus	19.5***	0.4	1.7
Calculus	10.0	0.0	0.2

* Percentages are weighted to yield population estimates.

** Standard errors were not reported.

*** Differences between 1982 and 1987 graduates are significant at 0.05 level.

Source: Westat (1988), Table 35.

Table 14

Percent* of High School Graduates Who Took Selected Science Courses, by Academic Track, 1982 and 1987

Science Courses	Curricular Track: Academic	Vocational	Other
1982 Graduates			
Biology	91.8**	58.3	62.2
Chemistry	59.2	5.8	9.6
Physics	30.0	1.4	1.7
1987 Graduates			
Biology	95.8***	75.3***	77.6***
Chemistry	67.3***	4.6	12.4***
Physics	31.7***	0.9	0.9***

* Percentages are weighted to yield population estimates.

** Standard errors not reported.

*** Differences between 1982 and 1987 graduates are significant at 0.05 level.

Source: Westat (1988), Table 43.

Table 15

Course-taking Patterns of College-bound Seniors
who Took the SAT in 1982 and 1987

	Percent Meeting NCEE Recommendations	
	1982	1987
Four or more years of English	92.2	87.5
Three or more years of Mathematics	87.3	92.3
Three or more years of Science	(NA)*	71.9
Three or more years of Social Studies	80.5	82.3
Two or more years of Foreign Language	73.7	82.2

*Data were reported separately for biological science and physical science in 1982.

Sources: Ramist and Arbeiter (1984) and College Entrance Examination Board (1987).

Course-taking Patterns by Curricular Track

The Westat transcript study allows us to compare changes in course-taking across curricular tracks as well. Table 13 shows that increases in the percent of students taking algebra 1 were significant across all three curricular tracks, but increases in higher level mathematics course-taking were significant only for the academic track students. With regard to science, significant increases in course-taking are found in all three courses for academic track students, although the increase in the percent of students taking physics is small (Table 14). There are large and statistically significant increases in the percent of vocational and "other" track students taking biology, but small decreases in the percentage of vocational track students who took chemistry and physics and in the percentage of "other" track students who took physics.

Table 15 shows the course-taking patterns of college-bound seniors who took the SAT in 1982 and 1987. Since the background questionnaire for the SAT did not ask about specific courses taken, this comparison is limited to the percentage of students who reported taking a specified number of courses in the major academic fields. We used the recommendations of the National Commission on Excellence in Education (NCEE, 1983) to compare changes in course-taking.

The table shows that the percent of college-bound seniors who took three years of mathematics increased by five points, while the percent taking four years of English decreased by a comparable percentage. The largest increase was in foreign languages: nearly nine percent more students reported taking at least two years of a foreign language in 1987 than in 1982.

SUMMARY AND DISCUSSION

In summary, there were large increases in the percentage of students taking all college preparatory mathematics courses between 1982 and 1987 and the changes were significant across gender and racial/ethnic groups. The increases were particularly large in the upper level mathematics and science courses and among minority students. With the exception of biology the gains tended to be concentrated among students in the academic track.

Because of the timing of state education reform initiatives, we expected most of the growth in course-taking to have occurred after 1984. The data generally do not support this expectation. We found considerably larger increases in the percentage of students taking algebra 1, geometry and algebra 2 occurring between 1982 and 1984 than between 1984 and 1987. It appears that the percentage of students taking algebra 2 declined during this latter period. Unlike mathematics, changes in the percentage of students taking biology and chemistry were distributed more evenly over the five year period, especially for White students.

Course-taking Patterns in 1983-84

Analyses of the 1983-84 NAEP data show that course-taking at the eleventh grade varied by racial/ethnic group and by level of parental education. White and non-language minority Asian eleventh graders and eleventh grade students whose parents had some postsecondary education are more likely to take college-preparatory mathematics courses and advanced science courses than are students of other racial/ethnic groups or students from families with less formal education. These findings are similar to those from other research studies. For example, analyses of the number and type of courses taken by high school students in the period 1980-82 (High School and Beyond data) also found that White students were more likely to take college-level mathematics and science courses (Rock et al., 1986). Blacks and Hispanics tended to take more courses in basic skills, general mathematics and pre-algebra than Whites. As with the NAEP sample, there was considerably more variability in the percent of students taking advanced science courses

than in the percent taking biology. Significant sex differences in mathematics course-taking did not appear until the most advanced courses--algebra 3, geometry 2 and calculus.

The reasons for students to have access to, or be denied the opportunity of, particular course work are diverse. They include such factors as the availability of personnel in the school, state and local curriculum requirements, guidance counseling systems, choices made by students and the perception among school officials of the students' ability to benefit from the material to be presented.

The limited number of background variables in the NAEP data base required us to construct a fairly simple model of the determinants of course-taking. Our model showed that for most racial/ethnic groups students' educational expectations contributed significantly to differences in the number of courses taken by eleventh grade students. The level of parental education and number of study aids in the home were also positively related to the number of courses taken by White eleventh graders, and to a much lesser extent, by Blacks. It is interesting to note that parental education had a greater impact on course-taking than did educational expectations for White students, but the reverse is true for Blacks, non-language minority Hispanics and language minority Asians.

These patterns are consistent with earlier research. The background data available from NAEP, however, are insufficient to explain these variations. The more extensive HS&B data base has enabled researchers to specify a more comprehensive model of course-taking behavior and to account for much more of the variation in the number of courses taken by high school students. NAEP must also collect more data on the availability of courses in its sample schools before researchers can give better explanations for differences in course exposure.

Trends in Course-taking at the High School Level

A major purpose of this study was to use 1983-84 NAEP data as a baseline for measuring the impact of the education reform on student course-taking. We found, however, that changes in course-taking of the high school level preceded the publication of A Nation at Risk and state-

level initiatives that increased high school course work requirements. How do we explain these findings? One hypothesis concerns the validity of the data used to make these comparisons throughout the period 1982 and 1987. The data on 1982 high school seniors are drawn from transcripts while those on 1984 eleventh graders are taken from self-reports of course-taking. In addition, the 1984 eleventh graders were asked if they had taken pre-algebra or algebra 1; the 1982 transcript data are limited to algebra 1. While the 1986 self-reports appear to have face validity, the student reports in 1984 may be overstating the number and type of courses taken, making the increase in course-taking larger than is actually the case.

A second hypothesis suggests that the education reform movement began quietly at the local level before the publication of A Nation at Risk and the rush of state reform legislation in 1983 and 1984. Educators may have responded to a backlash to the "relevance" movement of the 1970s, a response triggered in part by reports of declining test scores during this time (c.f., Advisory Panel on the SAT Score Decline, 1977). They, along with students, parents and counselors, may also have been responding to stiffer entrance requirements that were beginning to be imposed by colleges and universities in the early 1980s. Between 1982 and 1985 nearly one-third of the states enacted more stringent admissions policies for their public colleges and universities. In addition, institutions of higher education in ten states that do not set statewide admission policies imposed or strengthened high school course work requirements during that period (Goertz & Johnson, 1985). The total number of years of study of academic subjects reported by college-bound seniors increased from 16.0 in 1980 to 16.61 in 1985. These increases were primarily in mathematics (+0.21) and physical sciences (+0.13) (Ramist & Arbeiter, 1986). This hypothesis is supported by the finding that most of the course-taking changes in the NAEP sample involved students in the academic track.

A third hypothesis posits that many districts responded to mandated increased course work requirements in the mid-1980s by increasing the number of basic, general or remedial level sections, rather than adding sections of more academically rigorous courses. "Affluent schools and districts and college preparatory students typically were not affected by the reforms, usually because they already responded to high university entrance

requirements" (Clune, 1989). In 1982, students in high SES schools already took an average of 2.2 years of mathematics and 1.9 years of science (Ekstrom, Goertz & Rock, 1988).

It appears from the Westat, Inc. transcript data that many students, especially those not in the academic curriculum, are fulfilling the new state mathematics and science course work requirements with lower-level courses. For example, 98.8 percent of the 1987 graduates in the vocational curriculum took at least one mathematics course. Only two-thirds took algebra 1 and fewer than 20 percent took both algebra 1 and geometry. All graduates in the academic curriculum took at least one mathematics course: 81 percent took algebra 1 and 80 percent took both algebra and geometry. A similar pattern occurs in science. While nearly all 1987 graduates took a science course, only two-thirds of the students in the academic curriculum took both biology and chemistry. The corresponding percentage among students in the vocational curriculum was 26 percent. Thus, while stricter course work requirements led to more students taking algebra 1 and biology, they have not had the intended effect of increasing course-taking in advanced mathematics and science courses, especially among students in non-academic curricular tracks.

Did the impact of education reform on course-taking peak in the mid-1980s? Most likely not. Some biology and chemistry, show a steady increase in enrollments through 1987. And mandated increases in course work requirements are just now going into effect in several states.

The findings from this study are preliminary. They provide a baseline for measuring the impact of the education reform movement on student course-taking at the high school level and raise a number of hypotheses to be tested by further research. NAEP will continue to collect not only the kinds of data reported here, but expanded information on high school students' curricular tracks, school district course work requirements for high school graduation, and the availability of selected advanced academic courses. Information from the biennial assessments will enable researchers to address the following kinds of questions:

- Will the increase in state-mandated course work requirements for high school graduation have an impact on student course-taking in the late 1980s? Will high school students in the Classes of 1988

and 1990 take more semesters of mathematics, science and foreign language than earlier graduates? Fewer vocational education courses? Will more students take advanced mathematics and science courses, or will they meet the new requirements with introductory courses?

- Will state-mandated course work requirements mediate the relationship between student socio-economic status and race/ethnicity and course-taking? Will more Black and Hispanic students take advanced courses in high school? Will the course-taking differences between low and high SES students narrow by the end of the decade?

- What is the effect of changed course work requirements on course-taking patterns across curricular tracks? Are there racial/ethnic or SES differences in course-taking within curricular tracks?

- How do schools differ in the number and type of courses required for high school graduation? Offered to high school students? What school characteristics are related to these differences?

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Appendix A

Text of Course-taking Questions in the 1983-84 NAEP

All Eleventh grade students were asked the following question:

Starting with the beginning of the tenth grade and through the end of this school year, how much course work will you have taken in each of the following subjects? Count only courses that meet at least three times (or three periods) a week. (Circle one letter for each line.)

	None	1/2 year	1 year	1 1/2 years	2 years	2 1/2 years	3 years	More than 3 years
Mathematics	A	B	C	D	E	F	G	H
English or literature	A	B	C	D	E	F	G	H
Journalism	A	B	C	D	E	F	G	H
Foreign language	A	B	C	D	E	F	G	H
History or social studies	A	B	C	D	E	F	G	H
Science	A	B	C	D	E	F	G	H
Computers or computer programming	A	B	C	D	E	F	G	H
Business or vocational courses	A	B	C	D	E	F	G	H
Arts	A	B	C	D	E	F	G	H
Music	A	B	C	D	E	F	G	H

A sample of eleventh grade students was asked the following three questions.

Which of the following courses have you taken, including the courses you are taking this semester? (Circle one letter for each line.)

	Yes, have taken	No, have not taken
General science.	A	B
Biology.	A	B
Chemistry.	A	B
Physics.	A	B

Other science courses (Please list)

_____

_____

_____

Which of the following courses have you taken, including the courses you are taking this semester? (Circle one letter for each line.)

	Yes, have taken	No, have not taken
General Math 1.	A	B
General Math 2.	A	B
First year algebra.	A	B
Second year algebra	A	B
Geometry.	A	B
Calculus.	A	B

Other math courses (Please list)

_____

_____

Have you taken any high school courses in the following areas? (Circle one letter for each line.)

	Yes	No
Agriculture, including horticulture.	A	B
Auto mechanics	A	B
Commercial arts.	A	B
Computer programming or computer operation	A	B
Construction trades: carpentry, cabinetmaking, or millwork	A	B
Construction trades: electrical	A	B
Construction trades: masonry.	A	B
Construction trades: plumbing	A	B
Cosmetology, hairdressing, or barbering.	A	B
Drafting	A	B
Electronics.	A	B
Home economics, dietetics, or child care	A	B
Machine shop	A	B
Medical or dental assisting.	A	B
Practical nursing.	A	B
Food serve occupations	A	B
Sales or merchandising	A	B
Secretarial, stenographic, typing, or other office work.	A	B
Welding.	A	B

Other (Please list) _____

Appendix B

Text of Course-taking Questions in the 1985-86 NAEP

All eleventh grade students were asked the following question:

Counting what you are taking now, have you ever taken any of the following mathematics, science and computer courses?

Mathematics:

- General, business, or consumer mathematics
- Pre-algebra or introduction to algebra
- First-year algebra
- Second-year algebra
- Geometry
- Trigonometry
- Pre-calculus or calculus

Science:

- General science
- Biology
- Chemistry
- Physics

Computer science:

- Computer competence or computer literacy
- Computer programming

Appendix C

Text of Course-taking Questions in the 1982 and 1987 SAT Student Descriptive Questionnaire

In 1982, SAT test-takers were asked to:

Blacken the letter corresponding to the total years of study you expect to complete in certain subject areas. Include in the total only courses you have taken since beginning the ninth grade and those you expect to complete before graduation from high school. Count less than a full year in a subject as a full year. Do not count a repeated year of the same course as an additional year of study.

(A) One year or the equivalent
(B) Two years or the equivalent
(C) Three years or the equivalent
(D) Four years or the equivalent
(E) More than four years or the equivalent
(F) I will not take any course in the subject area.

English

Mathematics

Foreign Languages

Biological Sciences (for example, biology, botany, or zoology)

Physical Sciences (for example, chemistry, physics, or earth science)

Social Studies (for example, history, government, or geography)

In 1987, SAT test-takers were asked the following question:

Indicate the total number of years of high school courses (in grades 9 through 12) you have taken or plan to take in each of the subjects listed below. If you have not taken any course in a subject and do not plan to take one in high school, fill in the oval in the "None" column. If you repeat a course, count it only once. If one (or more) of the courses is an advanced placement, accelerated, or honors course, fill in the oval in the "Honors" column.

Arts and Music (for example, art, music, art history, dance, theater)

English (for example, composition, grammar, or literature)

Foreign and Classical Languages

Mathematics

Natural Sciences (for example, biology, chemistry, or physics)

Social Sciences and History (for example, history, government, or geography)